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B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

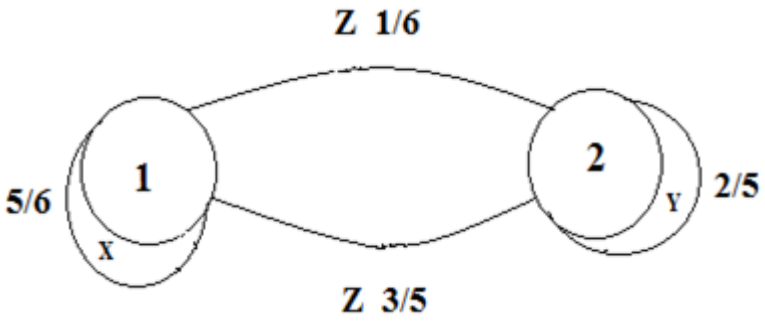
January / February 2025 Semester End Main Examinations

Programme: B.E. **Semester: V**
Branch: Electronics and Telecommunication Engineering **Duration: 3 hrs.**
Course Code: 19ET5PCITC **Max Marks: 100**
Course: Information Theory and Coding

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

		UNIT - I	*CO*	*PO*	**Marks**
1	a)	Arrive at the input probabilities for the given state equations. Obtain the code tree at the end of the first symbol interval and prove that $G_1 > H(S)$, the entropy of the Source. P(A)= P P(A) + P P(C) P(B) = P P(B) + P P(A) P(C) = P P(C) + P P(B)	*CO2*	*PO2*	**10**
	b)	Show that (i) H(X, Y) = H(X/Y) + H(Y) (ii) H(X/Y) = 0 when X = Y	*CO2*	*PO2*	**06**
	c)	A balanced two sided dice are thrown. The probability and the information of the events are (i) One roll is a four given that sum is seven. (ii) The first throw is a 6 and a second throw is a 3 or a 2. (iii) The value of 2nd roll subtracted from the value of first throw is 3.	*CO2*	*PO2*	**04**
		OR			
2	a)	The Probability of the output symbols are given below. Arrive at the probability of the input symbols and obtain the Joint probability matrix. Calculate H(X), H(Y), H(X, Y), H(X/Y), H(Y/X) and I(X, Y). $P(y_1)$ = 0.05 +0 + 0 + 0.05 $P(y_2)$ = 0 +0.10 + 0 + 0.05 $P(y_3)$ = 0.20 +0.10 + 0.20 + 0 $P(y_4)$ = 0.05 +0 + 0.10 + 0.10	*CO2*	*PO2*	**10**
	b)	For the First order Markov Source,	*CO2*	*PO2*	**10**



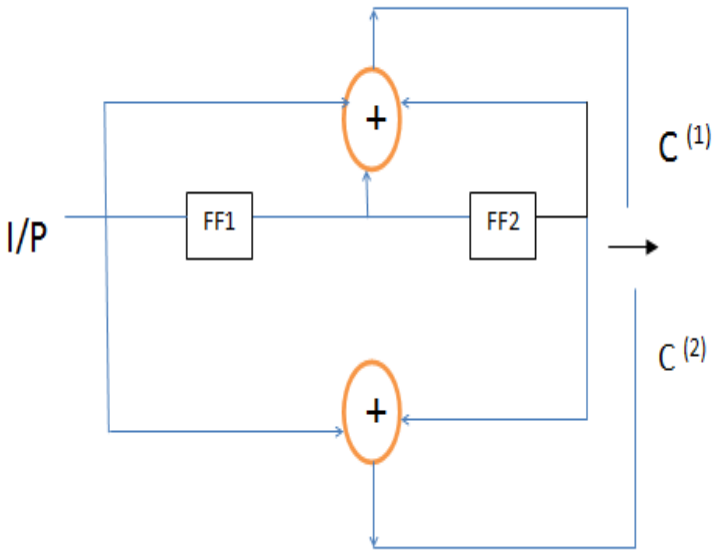
i) Find the stationary distribution, Entropy of each state and entropy of the source.

ii) Find G_1, G_2 and Show that $G_1 > G_2 > H$.

		UNIT - II			
3	a)	State and prove Noiseless coding theorem	*CO2*	*PO2*	**06**
	b)	Consider a source with 8 alphabets A to H with respective probabilities of 0.22, 0.20, 0.18, 0.15, 0.10, 0.08, 0.05, and 0.02. Construct a binary Huffman code and determine the code efficiency and redundancy.	*CO2*	*PO2*	**07**
	c)	A source produces two symbols A and B with the probabilities 0.05 and 0.95 respectively. Construct a Shannon fano binary code such that the efficiency of the coding is atleast 65%.	*CO2*	*PO2*	**07**
		OR			
4	a)	Apply Shannon's encoding algorithm to the following messages S1 S1 S3 0.5 0.3 0.2 Find Code efficiency and redundancy. If the same technique is applied to the second order extension of this source, how much will the efficiency improved.	*CO2*	*PO2*	**07**
	b)	Identify the instantaneous codes for the codes listed in the table below. Construct their individual Decision trees **Source Symbols** / **Code-A** / **Code-B** S_1 0 0 S_2 10 01 S_3 110 001 S_4 1110 0010 S_5 1111 0011	*CO2*	*PO2*	**06**
	c)	Discuss the various properties of codes.	*CO2*	*PO1*	**07**
		UNIT - III			
5	a)	Consider the cascading of two channels having the following noise matrices.	*CO2*	*PO2*	**10**

			$P(Y/X) = P(Z/Y) = \begin{bmatrix} 0.8 & 0.2 \\ 0.2 & 0.8 \end{bmatrix}$ (i) Find the noise matrix of the cascaded channel **(ii)** Find I(X,Y) and I(X,Z)			
	b)	Obtain an expression for the Channel capacity of Symmetric/Uniform channel.		*CO2*	*PO2*	**10**
			OR			
6)	a)	An analog signal has a 5 KHz bandwidth. The signal is sampled at 2.5 times the Nyquist rate and each sample quantized into 186 equally likely levels. Assume that the successive samples are statistically independent. (i) Find the Information rate of this source. (ii) Can the output of this source be transmitted without errors over a Gaussian channel of bandwidth 20 KHz and (S/N) ratio of 20db? (iii) If the output of this source is to be transmitted without errors over an analog channel having (S/N) of 30 dB, Compute the bandwidth requirement of the channel.		*CO2*	*PO2*	**06**
	b)	Derive an expression for channel capacity of Binary Symmetric Channel		*CO2*	*PO2*	**07**
	c)	A CRT terminal is used to enter alphanumeric data into a computer. The CRT is connected through a voice grade telephone line having usable bandwidth of 3 KHz and an output (S/N) of 30 dB. Assume that the terminal has 128 characters and data is sent in an independent manner with equal probability. (i) Find the average information per character. (ii) Find the capacity of the channel. (iii) Find maximum rate at which data can be sent from terminal to the computer without error.		*CO2*	*PO2*	**07**
			UNIT - IV			
7	a)	Identify (n , k) values of the cyclic codes generated by the following generator polynomials, given $n \leq 7$ (i) $g(x) = 1+X^2+X^3$ (ii) $g(x) = 1+X+X^2+X^4$ (iii) $g(x) = 1+X^2+X^3+X^4$		*CO3*	*PO2*	**06**
	b)	Device a feedback shift register encoding circuit for a (15, 7) cyclic code generated by the polynomial $g(x) = 1+x^4+x^6+x^7+x^8$. (i) Find the code vector for the message polynomial $d(x) = 1+x^2+x^3+x^4$ in systematic form. (ii) Assume the first and the last bit of the code vector suffers transmission errors. Find the syndrome of code vector.		*CO3*	*PO2*	**08**

		c)	Design an encoder for (n, k) binary cyclic code generated by $g(x) = 1+ X+X^3$. Identify 'n' for 4 message bits. Compute the input message for the encoder by considering the content of the shift register given below. No of Shifts | Input | Shift Register Contents (R_0 R_1 R_2) | | 0 0 0 1 | ? | 1 1 0 2 | ? | 1 0 1 3 | ? | 1 0 0 4 | ? | 1 0 0	*CO3*	*PO3*	**06**
			OR			
	8	a)	Prove that $CH^T = 0$, where C is a valid Code vector and H^T is the transpose of the parity check matrix.	*CO3*	*PO2*	**04**
		b)	For a systematic (7, 4) LBC, the parity matrix is given below. Draw the Encoding and Syndrome Calculation circuit. An error has occurred in the received Vector R = [1011100]. Detect and correct the error. $\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 0 \\ 1 & 0 & 1 \\ 0 & 1 & 1 \end{bmatrix}$	*CO3*	*PO2*	**08**
		c)	A (6,3) code has the following check bits $C_4 = d_1+d_2$ $C_5 = d_1+d_3$ $C_6 = d_2+d_3$ (i) Write G and H matrices and obtain the code vectors (ii) Construct the standard array for the code	*CO3*	*PO2*	**08**
			UNIT - V			
	9	a)	For the given Generator matrix, obtain n, k, m values of the convolutional encoder and draw the encoder diagram. $\begin{bmatrix} 111\ 101\ 011\ 000\ 000\ 000\ 000 \\ 000\ 111\ 101\ 011\ 000\ 000\ 000 \\ 000\ 000\ 111\ 101\ 011\ 000\ 000 \\ 000\ 000\ 000\ 111\ 101\ 011\ 000 \\ 000\ 000\ 000\ 000\ 111\ 101\ 011 \end{bmatrix}$	*CO3*	*PO3*	**06**
		b)	Consider the (2, 1, 2) convolutional code with $g^{(1)} = 111$ and $g^{(2)} = 101$. (i) Draw the encoder block diagram (ii) Draw the state table and state transition table (iii) Draw the state diagram and the corresponding code tree.	*CO3*	*PO2*	**10**

			(iv) Find the encoded sequence for the message 10111 by tracing the path through the code tree.			
		c)	Consider the (2, 1, 2) convolutional code with $g^{(1)} = 111$ and $g^{(2)} = 101$. (i) Find the encoded sequence for the message 10111 by tracing the path through the code tree.	*CO3*	*PO2*	**04**
			OR			
	10	a)	For a convolutional code, with $g^{(1)} = 1\ 1\ 0$, $g^{(2)} = 1\ 0\ 1$ and $g^{(3)} = 1\ 1\ 1$. (i) Draw the encoder block diagram. (ii) Find the generator matrix. (iii) Find the code word corresponding to the information sequence 1 1 1 0 1 using time domain and transform domain approach.	*CO3*	*PO2*	**10**
		b)	For the binary convolutional encoder given below. Draw the state table, state transition table, State diagram and corresponding code tree. Using the code tree, find the encoded sequence for the message 11100. Verify the sequence using transform domain approach. 	*CO3*	*PO2*	**10**

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